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RISK FACTORS AND EFFECTS OF HOOKWORM INFECTIONS ON ANTHROPOMETRIC INDICES OF SCHOOL CHILDREN IN SAMARU, ZARIA, NIGERIA

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ABSTRACT
Rural communities in Nigeria suffer a great deal of parasitic infections. The effect is severe on children. Parasitic infections affect the health of schoolchildren by causing malnutrition, anaemia, reduced cognitive ability and poor performance in school. This study was aimed at assessing the prevalence of hookworm infections, associated risk factors and their effects on anthropometric indices of schoolchildren in Samaru, Zaria. Children across public and private schools were enlightened about the disease. Fresh morning faecal samples were collected from each of 203 consented pupils. The samples were examined for hookworm eggs by formol-ether concentration technique. Prevalence of hookworms was 4.9%. Children in four out of seven schools were found with hookworm infections (P=0.000). Children from public schools were significantly more infected with hookworms (7.9%, P=0.050) than those in the private schools. Male schoolchildren had higher hookworm infections (5.8%) than the females (4.7%, P>0.05). The youngest children of age 6-7 years old were the most infected (9.1%); followed by those of 10-11 years old who had 5.8% infections. Children who walked barefooted (6.5%), consumed raw vegetables (5.1%) or engaged in farming (5.3%) were more infected with hookworms than those who did not, but the relationship was not significant (P>0.00). Only fever (3.0%) was found among infected children (P=0.582), other symptoms did not occur among those infected with the hookworms. Children with weight of 39-48kg had the highest infection of 8.0%. Weight, height and BMI were not statistically associated with hookworm infections among the children. However, most of the children (87.2%) had underweight BMI.

Keywords: Hookworms, body mass index, schoolchildren, Samaru, sanitation, infection.

INTRODUCTION

About half of the world's population is affected by intestinal helminths (Hall *et al*., 2008; Bishop and Yohanna, 2018). Since helminths have an inseparable relationship with the soil, they are often referred to as soil-transmitted helminths (STHs) or geohelminths. Children are very vulnerable to intestinal helminths (Abah and Arene, 2015) due to their play habits with soil (Montressor *et al.,* 2002). They often play on contaminated sand, and thereafter lick their fingers, consume unwashed fruits/vegetables and even swallow soil and dirt (Montressor *et al.,* 2002). *Ancylostoma duodenale* and *Necator americanus* are the two important species of hookworms infecting man with an estimated 1.2 billion cases worldwide (Scott, 2008). Though *Ascaris lumbricoides* is the most common intestinal parasite worldwide, infections with hookworms can lead to loss of micronutrients and blood from the intestinal wall (Stephenson *et al.,* 2000) with consequent side effects like anaemia especially during heavy infections (Koukounaria *et al.*, 2008). Hookworms are known to promote severity and persistence of iron-deficiency anaemia (Odebunmi *et al*., 2007). Occurrence of this parasite is common in rural areas of undeveloped nations (Sinniah *et al.*, 2014). Many intestinal helminthic infections directly cause the loss of fluid, nutrients and electrolytes from the body. In children, it can lead to growth stunting (Oluboyo *et al*., 2014). Most children are unaware of the danger of some of their daily behaviours like playing on contaminated soil, geophagy, consumption of unwashed fruits and drinking of water from doubtful sources.

MATERIALS AND METHODS

Study area and population

Samaru is a rural community in Zaria. Zaria is gradually becoming an urban area in Kaduna State, Nigeria. The area has large number of tertiary instructions and research centers. However, inadequate sanitation is still a persistent problem in the various communities. The study population comprised of children from different public and private schools within Zaria. Consents were obtained from parents and school managements to enroll 203 children between the ages of 6-13 years old. Participation in the study was voluntary.

Questionnaire administration and determination of body mass index

Structured questionnaires were used to obtain information on socio-demography, risk factors and associated symptoms of the hookworm infections among the pupils with the help of their teachers and parents. The weight (kg) and height (m) of each pupil were measured using a weighing balance and a meter rule without shoes and with minimum clothing. Body mass index (BMI) was calculated as the weight in kilogrammes divided by the square of height in meters. Children's BMI were classified according to WHO (2006) BMI classification as: underweight (<18.50), severe thinness (<16.00), moderate thinness (16.00 -16.99), mild thinness (17.00 -18.49), normal (18.50-24.99), overweight (≥25.00), pre-obese (25.00-29.99), obese (≥30.00), obese class I (30.00-3.99), obese class II (35.00-39.99), obese class III (≥40.00).

Collection of faecal samples

A total of 203 faecal samples were collected. A screw-capped, wide mouth container was given to each participant, with instructions on

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how to obtain fresh early morning stool sample. The samples were examined at the Department of Parasitology and Entomology, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria.

Detection of Hookworm eggs by formol-ether concentration technique

Using an applicator stick, about 3g of each faecal sample was emulsified in 7mL of 10% formol saline in a test tube. The suspension was sieved through fine mesh gauze in a plastic funnel into a collecting centrifuge tube to remove large faecal particles. Then 3mL of diethyl acetate was added to the filtrate and shaken vigorously for about one minute. The suspension was centrifuged at 3000 revolution per minute for five minutes. Four distinct layers were formed: the top layer of ether and dissolved fats, thin layer of faecal debris, formol water and sediment at the bottom of the tube. The supernatant was decanted carefully, leaving the sediment at the bottom of the tube. The sediment was transferred by means of a Pasteur pipette onto a clean grease-free glass slide and covered with a cover slip. Examination for parasites was done using 10x and 40x objectives of the light microscope with the help of coloured parasitological atlas (Cheesbrough, 2009).

Statistical analysis

Data obtained from administered questionnaires together with laboratory results were subjected to statistical analysis by Chi square (χ^2) and Odd Ratio (OR). The final results were presented in a chart and table.

RESULTS

Prevalence of hookworm infections in schoolchildren in Samaru, Zaria was found to be 4.9% (Figure 1). Children from four out of seven schools were found with hookworm infections (P=0.000). Children from schools S_4, S_6, S_3 and S_5 had 21.9%, 4.3%, 2.9% and 1.9% hookworm infections respectively (Table 1). Comparatively, children from public schools were significantly more infected with hookworms (7.9%, P=0.050) than those in the private schools (Table 2). In Table 3, male children had higher hookworm infections (5.8%) than the females (4.7%), but the relationship was not significant (P=0.892). The youngest children of age 6-7 years old were the most infected (9.1%); followed by those of 10-11 years old who had 5.8% infections (Table 4). Children who went about barefooted were more infected (6.5%) than those who regularly put on shoes (3.6%). Also, those who consumed raw vegetables and participated in farming were more infected with hookworms than those who did not, but the relationships were not significant (P>0.05) as shown in Table 5. Of the possible symptoms considered for hookworm infections among the children, only fever occurred among those infected, which was not significant (Table 6). The highest hookworm infections (8.0%) occurred in children with body weight of 39-48kg and the lowest was 1.6% among children with weight of 19-28kg (Table 7). In terms of height, infections were found only in those of 1.2-1.4m tall. Both weight and height had no significant relationships with hookworm infections among the children. Occurrence of underweight BMI among the children was 177(87.2%), but only 4.0% had hookworm infections, which was also not significantly associated with the BMI (Table 7).

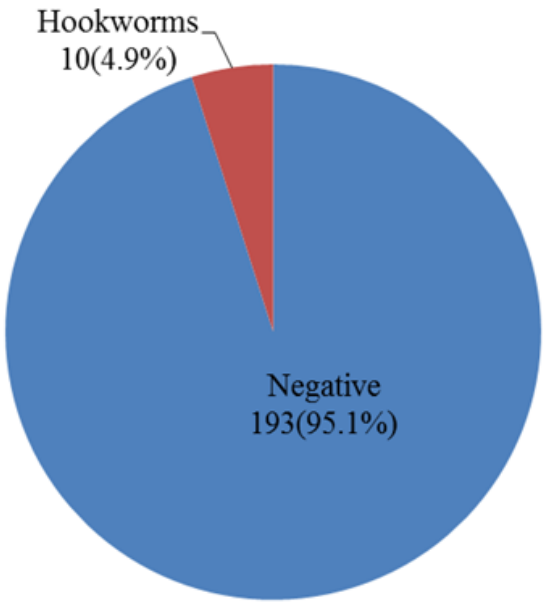

Figure 1: Overall prevalence of Hookworm infections among schoolchildren in Samaru, Zaria

Table 1: Distribution of Hookworm infections among children attending different primary schools in Samaru, Zaria

School	Number examined	Number Positive (%)
S_1	17	0 (0.0)
S_2	26	0 (0.0)
S_3	34	1 (2.9)
S_4	32	7 (21.9)
S_5	52	1 (1.9)
S_6	23	1 (4.3)
S_7	19	0 (0.0)
Total	203	10 (4.9)

χ^2=24.144, df=6, P=0.000

Table 2: Comparative occurrences of Hookworm infections in private and public schoolchildren in Samaru, Zaria

School type	Number examined	Number positive (%)
Private	102	2 (2.0)
Public	101	8 (7.9)

χ^2=3.349, df=1, P=0.050, OR=0.233

Table 3: Sex distribution of Hookworm infections among schoolchildren in Samaru, Zaria

Sex	Number examined	Number positive (%)
Female	107	5 (4.7)
Male	96	5 (5.2)

χ^2=0.031, df=1, P=0.860, OR=0.892

Table 4: Age distribution of Hookworm infections among pupils in Samaru, Zaria

Age group (years)	Number examined	Number positive (%)
6-7	12	1 (9.1)
8-9	36	1 (2.8)
10-11	120	7 (5.8)
12-13	35	1 (2.9)

χ^2=3.259, df=3, P=0.353

Table 5: Risk factors of Hookworm infections among schoolchildren in Samaru, Zaria

Risk factors	Category	Number examined	Number positive (%)
Walking barefooted*	No	110	4(3.6)
	Yes	93	6(6.5)
Eating of raw vegetables**	No	5	0 (0.0)
	Yes	198	10 (5.1)
Farming***	No	109	5(4.6)
	Yes	94	5(5.3)

*χ^2=0.853, df=1, P=0.356, OR=0.547
**χ^2=0.266, df=1, P=0.606, OR=1.053
***χ^2=0.058, df=1, P=0.810, OR=0.856

Table 6: Signs/symptoms of Hookworm infections among schoolchildren in Samaru

Sign/Symptom	Category	Number examined	Number Positive (%)
Abdominal pains[a]	No	161	10(6.2)
	Yes	42	0(0.0)
Diarrhoea[b]	No	176	10(5.7)
	Yes	27	0(0.0)
Fever*	No	170	9(5.3)
	Yes	33	1(3.0)
Vomiting**	No	175	10(5.7)
	Yes	28	0(0.0)

[a]χ^2=2.744, df=1, P=0.098, OR=0.938
[b]χ^2=1.614, df=1, P=0.204, OR=0.943
*χ^2=0.302, df=1, P=0.582, OR=1.789
**χ^2=1.683, df=1, P=0.195, OR=0.943

Table 7: Effects of Hookworm infections on anthropometric indices of schoolchildren in Samaru, Zaria

Anthropometric index	Category	Number examined	Number positive (%)
	19-28	61	1 (1.6)
	29-38	117	7 (6.0)
Weight(kg)*	39-48	25	2 (8.0)
	1.10-1.19	7	0 (0.0)
	1.20-1.29	28	1 (3.6)
Height(m)**	1.30-1.39	80	4 (5.0)
	1.40-1.49	69	5 (7.2)
	1.50-1.59	14	0 (0.0)
	1.60-1.69	5	0 (0.0)
Body mass index (BMI)***	Normal weight	26	3 (11.5)
	Underweight	177	7 (4.0)

* χ^2=2.008, df=2, P=0.366
** χ^2=2.251, df=5, P=0.813
*** χ^2=2.784, df=1, P=0.095, OR=3.168

DISCUSSION

The detection of 4.9% hookworm eggs in stool samples of schoolchildren from Samaru, Zaria is an evidence of intestinal infections among the pupils. Children from Nigeria suffer from different neglected tropical diseases, which remain great health challenges of the 21st Century (Bishop, 2017). Children's health is the responsibility of parents and the government, and must not be neglected. Within Nigeria, higher prevalence of 5.14% of hookworms in children from Jos-North, Plateau State had been reported (Bala and Yakubu, 2010), 5.8% among children in orphanages of Anambra State (Oluboyo *et al.*, 2014), and 25.0% in children from Rivers State (Abah and Irene, 2015). However, the prevalence in this study is higher than reported prevalence of 3.2% among schoolchildren from Vom in Plateau State, Nigeria (Odebunmi *et al.*, 2007). Differences in the various reports could be due mainly to prevailing environmental and sanitary factors. If a settlement has adequate sanitary facilities, properly disposes human and animal wastes and maintains good personal hygiene, then children will not become victims of soil-transmitted helminths. There was significant difference in the occurrence of hookworms among children from the different schools (P=0.000). There was absence of the infection in three schools, but exceptionally higher in three other schools indicating a difference in levels of local sanitation and hygienic practice among the children. As such, parents, school managements and the government must provide good and adequate sanitary facilities in each school and the children should be trained on good practice of personal hygiene.

Children who attended public/government primary schools in this study were significantly (P=0.05) more infected than those in the private schools. Of course, in the public schools, population of children outweighs available sanitary resources; school compounds are not fenced, playgrounds are open to various contaminations and there is general poor level of hygiene. Private schools are mostly not overpopulated, having and maintaining adequate environmental and sanitary conditions for learning. The argument on why children from private schools have less hookworm infections than those in public schools had been observed and reported by Odebunmi *et al.* (2007).

Hookworm infections among the males were higher than in the females. The relationship was not statistically significant as similarly reported by Bala and Yakubu (2010). Habits like playing football barefooted by boys on wet field can promote penetration of the skin by filariform larvae. The infection was higher in children of 6-7 years than any other age group probably because they have higher tendency of coming in contact with contaminated/infested soil during plays.

Children who regularly went about barefooted, consumed raw vegetables or assisted their parents at the farms were more infected than those who did not. Walking barefooted makes one easily come in contact with filariform larvae of hookworms, which initiate infection by penetrating intact skin. Vegetables can serve as vehicle for transmission of geohelminths and infections can occur when consumed. Farming on lands to which untreated human wastes are applied as manure is a great risk for transmission of different soil-transmitted helminths (Bishop and Yohanna, 2018).

None of the infected schoolchildren had abdominal pain, diarrhoea or vomiting. Such symptoms are mostly reported for other types of intestinal parasitic infections. However, fever (3.0%, OR=1.789) is likely to be seen due to migrating juvenile larval worms.

Children with the heaviest body weight had more hookworm infections than those who were lighter in weight; however, this

observation was not statistically significant. Though all the recorded infections were found in children with height between 1.20m-1.49m, there was no significant statistical relationship between height of the children and the hookworm infections. Though majority of the children were underweight, hookworm infections among them were not significantly related to it. In a similar study by Oluboyo *et al.* (2014), there was no significant association between low BMI and intestinal parasitic infections.

Conclusion

Eggs of hookworms were detected in stool samples of schoolchildren in Samaru, Zaria with an overall prevalence of 4.9%. The infections were significantly found in children from four out of seven schools considered in this study (P=0.000). There was significantly higher occurrence of hookworm infections (7.9%, P=0.05) among children in public schools. Male schoolchildren were more infected with the hookworms than females. Children who went barefooted, consumed raw vegetables or assisted their parents during farm work were more infected than others who did not; however, the relationship was not statistically significant. Hookworm infections in the children were not associated with any symptom in this study. Majority of the schoolchildren (87.2%) were underweight. This study did not prove any significant association between body mass index of children and hookworm infections.

Conflict of Interest

The authors declare that there is no financial or any other conflict of interest in this study.

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